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Full Length Research

Yam Postharvest Losses and Food Security in North Central Zone of Nigeria

*Nwafor S.C., Odor P.C. and Ebere O.S.

National Root Crops Research Institute Umudike, P.M.B. 7006.Umuahia. Abia State, Nigeria.

S.C. Nwafor; https://orcid.org/0000-0001-7499-1757

*Corresponding Authors' Contact Details: E-mail Address ✉: solomonnwafor8@gmail.com; Phone Number ☎: Tel: +2347035245706

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The study addressed the stages, causes, and effects of postharvest losses of yam and to the extent they affect food security in Nigeria. The study adopted a cross-sectional research design using a public opinion survey in 2 states (Benue and Nasarawa) of Nigeria. Data were obtained through interview schedules while a multi-stage sampling procedure was employed in the selection of 160 respondents for the study. The result highlights the gender disparity, age distribution, marital status, level of education, and family size among yam farmers in Nigeria. The result showed the highest percentage loss range is 15-19.9%, accounting for 28%. It further revealed that loss occurs more at storage (32%) followed by the processing stage (22%). The analysis revealed that the coefficient of harvest (-0.0192), storage (-0.0148), transportation (-0.0276), and processing (-0.0293) were inversely related to food security which is an indication that a unit rise in any of these factors will lead to a decrease to food security in Nigeria. The Chi-square value of 514.845 indicates the overall significance of the model in explaining the relationship between postharvest losses and food security which suggests that the variables collectively have a substantial impact on food security in the North Central Zone of Nigeria. The results emphasize the need for interventions and policies that focus on reducing postharvest losses of yam to improve food security, enhance economic capacity, and promote sustainable agriculture in the region. The findings show the stages, causes, and effects of postharvest losses of yam and their relationship to food security in Nigeria.

Keywords: Effect, Food Security, Postharvest Losses, Yam.

INTRODUCTION

Yam is a valuable food commodity across the global community, especially for people in tropical countries of West Africa who are acknowledged as major yam producers. In West Africa, yam is both a food and cash crop. It plays important role in the livelihood, standard of living, and food security of at least 60 million people in the region, in terms of income generation, access to healthcare services, education, housing, and food availability. About 57 million tons of yams (about 93% of global supply) are produced on 4.7 million hectares annually in the region, mainly in five countries namely: Benin, Cote d'Ivoire, Ghana,

Nigeria, and Togo. Interestingly, Nigeria alone accounts for about 70% of the global yam supply, with an annual production estimated at 40.5 million tones on 3.2 million hectares (Mignouna et al., 2014; Sanginga and IITA, 2015).

Nigeria is the leading yam producer with a volume of 34 million tonnes, followed by Cote D'Iviore with 5 million tonnes followed by Ghana (with 3.9 million tonnes) and Benin with 2.1 million tonnes. Ethiopia (with 174,000 tonnes) and Sudan (with 137,000 tonnes) are the major producers in East Africa. Columbia (333,000 tonnes) leads the production in South America followed by Brazil (230,000 tonnes) while Japan (204,000 tonnes) is the leader in Asia (IITA, 2009). Yams are also important in the Caribbean (for example, Haiti with 197,000 tonnes in 2005), and the South Pacific islands (IITA, 2009).

Nigeria is indeed, the world's largest producer of yam, contributing about 2/3 of the global yam production. The major yam-producing states in Nigeria include Adamawa, Benue, Nasarawa, Cross River, Delta, Edo, Ekiti, Imo, Kaduna, Kwara, Ogun, Ondo, Osun, Oyo and Plateau (Akangbe et al., 2012). Accordingly, Benue and Nasarawa States have been acclaimed as the major contributors to the yam production capacity of Nigeria and West Africa at large (Phillips, 2013), with the largest yam market in Africa - Zaki Biam yam market- in Benue state. The value of yam to Nigerian households is evident in the fact of its integration into the economic, social, cultural, and religious aspects of their lives (Okigbo and Ogbonnaya, 2006; Verter and Becvarova, 2014). Economically, yam is a cash crop, which plays an important role in the livelihood and standard of living of about 60 million people in West Africa, including Nigeria and Benue State, where it is predominantly cultivated (Mignouna, et al., 2014; Sanginga and IITA, 2015). This is because, over 60% of farming households in the North-central zone of Nigeria engage in yam cultivation, not only as a means of household food supply but also as a primary source of income (Izekor and Olumese, 2010).

In Nigeria, the current estimates of post-harvest losses indicate that quantitative and quality loss of yam is high and this translates to substantial amounts of money farmers lose every year. These losses translate not just into human hunger and financial loss to farmers, they also affect the standard of living of yam farmers who depend on it as the source of livelihood. Other necessities of life of the farmers are also affected such as; education, access to health care, clothing, housing, potable water, and so on (Iorzua et al., 2020).

Yams are highly perishable and very susceptible to mechanical damage when poorly harvested or handled. Postharvest food losses contribute to high food prices by removing part of the supply from the market. This study is timely in that it evaluates the stages, causes, and effects of postharvest losses of yam and to the extent it affects food security in the studied area.

METHODOLOGY

A survey research design was adopted for the study. The rationale for adopting this method is that it allows questions to be asked to respondents with the aid of questionnaire and interview schedule, by which, respondents can also be probed for clarification and further information. This gives room for considerable flexibility in analysis. The research was conducted in Benue and Nasarawa states in the North-central zone of Nigeria. Three local government areas were randomly selected from each of the states, then two (2) communities were randomly selected from each of the local governments. From each of the communities, ten (10) yam farmers were randomly selected. On the whole, 160 respondents were drawn for the study. A well-structured interview guide was used to elicit information from the selected yam farmers.

Face and content validity of the research instrument was carried out by an assortment of experts from the Department of Sociology, Benue State University Makurdi, Benue State Nigeria. Using the Test-retest method, Pearson Product Moment Correlation was used to ascertain the reliability of the survey instrument. With this in perspective, the instrument was considered consistent as a reliability coefficient of 0.81 was obtained. A semi-structured questionnaire was used to elicit information from the respondents. Items on the research instrument were developed to provide answers to the objectives of the study.

Data were collected on the demographics of the respondents; the estimated volume of yam losses after harvest, stages in the postharvest value chain where losses occurred the most, causes of yam losses after harvest, and also the effect of losses of harvested yam on food security of the farmers. Data were analyzed using descriptive statistics (such as frequency count on multiple choice tables, percentages, and averages) and inferential statistics

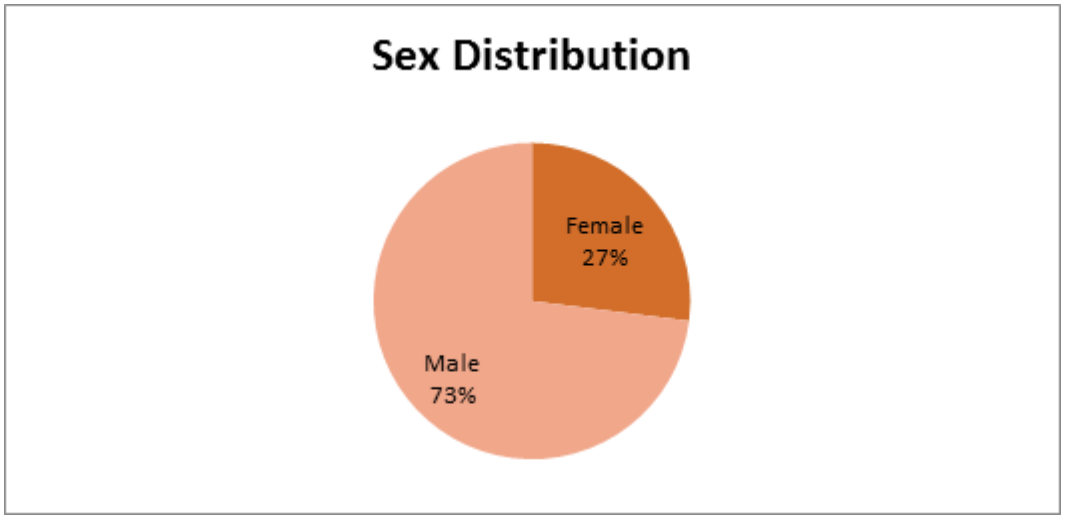

Figure 1. Sex distribution of yam farmers in North-Central states of Nigeria.

such as probit regression.

The probit model is given thus

$P(Y) = X_1\beta_1 + X_1\beta_1 \ldots\ldots X_n\beta_n + ei$ ……equation 1

$P(Y) = \beta_0 + X_1\beta_1 + X_1\beta_1 \ldots\ldots X_n\beta_n + ei$ ……..……equation 2

Where:

Y = Food accessibility (yes 1, otherwise no = 0: accessibility implies availability and affordability)

X_1 = yam lost due to poor handling; X_2 = yam lost during storage; X_3 = yam lost in transit; X_4 = quantity of yam lost during sorting, grading, and cleaning; X_5 = quantity of yam lost during Marketing; b_0 = intercept; b_1 = parameter estimate.

RESULT AND DISCUSSION

Demographic characteristics of yam farmers in the North Central States of Nigeria

Sex

According to the information presented in Figure 1, the survey results showed a significant skew towards male representation among yam farmers, with males comprising 73% of the respondents. In contrast, females accounted for only 27% of the yam farming population. This gender disparity in yam production is not unexpected, considering the labor-intensive nature of the activity. Yam farming involves various physically demanding tasks, such as land clearing, mound construction, yam staking, and weeding. These activities often require significant physical strength and endurance, making them traditionally associated with male participation. Consequently, men have been more involved in yam farming compared to women. The limited participation of women in yam production can be attributed to several factors. First, physical strength plays a crucial role in performing the demanding tasks involved in yam farming. Historically, societal norms and expectations have assigned men as the primary providers of physical labor, leading to a gendered division of agricultural work. Additionally, financial resources also play a role in limiting female participation in yam farming. Starting a yam farm requires capital investment for inputs like seeds, tools, and land preparation. Women, who often face restricted access to financial resources and land ownership, may encounter barriers in establishing their yam farms.

Age

The distribution presented in Figure 2 shows that the majority of yam farmers fall within the age range of 31-50 years, comprising 56% of the total farmers. This age group is likely to have significant farming experience and knowledge, which can contribute to better postharvest management practices. Their experience may include effective harvesting

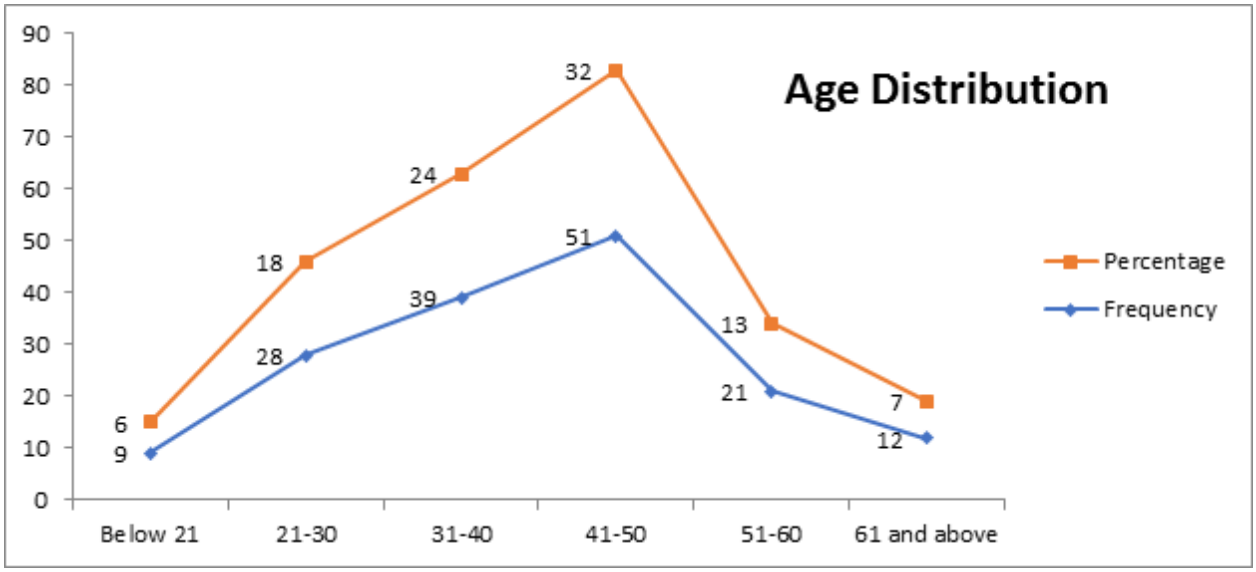

Figure 2. Age distribution of yam farmers in North-Central states of Nigeria.

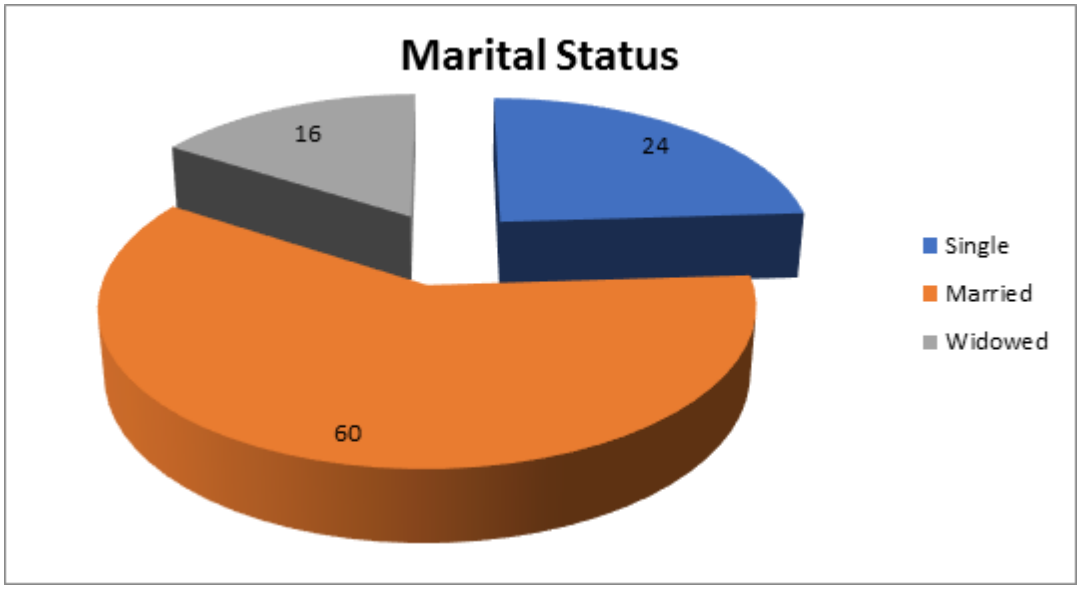

Figure 3. Marital status of yam farmers in North-Central states of Nigeria.

techniques, proper handling, storage, and processing methods, leading to reduced postharvest losses and improved food security. The result also indicates that 24% of the yam farmers are in the age range of 21-30 years, while 6% are below 21 years. Younger farmers may bring fresh perspectives, innovation, and adaptability to agricultural practices. However, they may have relatively less experience and knowledge in postharvest management, which could result in higher losses if proper training and support are not provided. Efforts should be made to equip younger farmers with the necessary skills and knowledge to minimize postharvest losses and enhance food security. The distribution also highlights that 20% of the farmers are 51 years and above. While older farmers may possess extensive

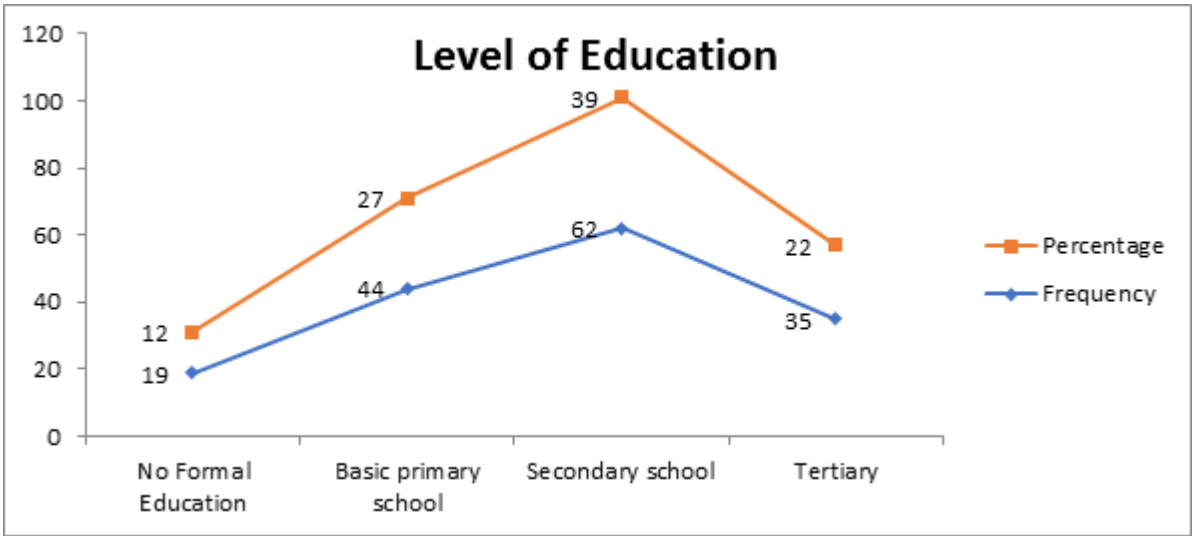

Figure 4. Level of education of yam farmers in North-Central states of Nigeria.

experience and traditional knowledge, they may face challenges related to physical strength and access to resources. This could affect their ability to effectively manage postharvest losses. Support mechanisms should be in place to assist older farmers in adopting improved postharvest practices and technologies, ensuring their continued contribution to food security. Overall, addressing postharvest losses and improving food security in Nigeria requires a multi-faceted approach that recognizes the diverse age demographics of yam farmers. It is important to provide appropriate training, support, and resources to farmers of all age groups, ensuring the adoption of effective postharvest management practices and the sustainable production of yam crops.

Marital Status

The result as presented in Figure 3 showed that 60% of the sample farmers were married, 24% were single and 16% were widowed.

The marital status of farmers can have an impact on the availability of labor for postharvest activities. Married farmers may have more access to family labor, including spouses and children, who can assist in postharvest handling, storage, and processing activities. This could potentially result in better management practices, reducing postharvest losses and improving food security. The level of knowledge and skills in postharvest handling techniques may vary among farmers based on their marital status. Married farmers, particularly those with more experience, may have acquired better knowledge and skills over time through shared experiences and intergenerational knowledge transfer. This could lead to improved postharvest practices, reducing losses and ensuring better food security. Marital status can also influence the access to resources and support systems. Married farmers may have access to better financial resources, social networks, and extension services, which can provide them with information, technologies, and support to effectively manage postharvest losses. This can positively impact food security by reducing losses and enhancing market opportunities for farmers.

The presence of widowed farmers in the distribution raises concerns about their vulnerability. Widowed farmers may face additional challenges in managing postharvest losses due to the lack of labor and support systems. They may have limited access to resources, knowledge, and markets, which could result in higher postharvest losses and lower food security for this group.

Level of Education

From Figure 4, 88% (141) of the respondents have had one form of formal education or the other, 39% (62) had attained secondary education, and 27% and 22% had had primary and tertiary education. However, only 12% (19) of the sampled population did not have any form of formal education.

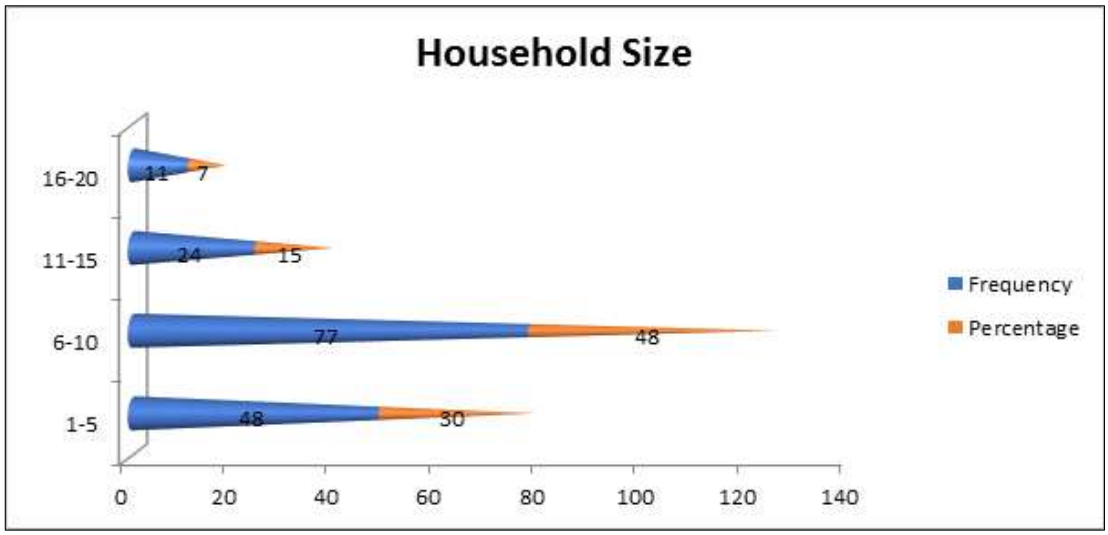

Figure 5. Household size of yam farmers in North-Central states of Nigeria.

The category of "No Formal Education" accounts for 12% of the yam farmers. This suggests that a portion of yam farmers in Nigeria have not received any formal education. Lack of education may influence their knowledge and understanding of modern agricultural practices, including postharvest handling techniques, which could contribute to higher postharvest losses. The result indicates that a significant number of farmers (27%) have completed primary education. While basic primary education provides foundational knowledge, additional training and exposure to agricultural practices may be needed to enhance their skills and understanding of postharvest management. Similarly indicates a relatively higher percentage of farmers (39%) with secondary education. Having completed secondary education suggests a broader knowledge base and potential exposure to agricultural concepts and practices. Farmers with secondary education may have a better understanding of postharvest handling techniques, which can help reduce losses. The category of "Tertiary Education" represents 22% of the yam farmers. This suggests that a considerable portion of farmers in Nigeria have obtained higher education qualifications. Tertiary education provides more in-depth knowledge and skills, which can positively impact the understanding and adoption of modern agricultural practices, including postharvest management. Farmers with tertiary education may be more likely to apply advanced techniques and technologies to reduce postharvest losses.

Household size

According to the data presented in Figure 5, 30% of households have 1-5 members, 48% have 6-10 members, 15% have 11-15 members, and 7% have 16-20 members. The distribution indicates that a significant majority of households (48%) fall within the 6-10 family member range. This suggests that larger families with six to ten members are the most prevalent in the population surveyed.

The findings also show that there is a wide variation in family sizes, ranging from single individuals or small families (1-5 members) to very large families (16-20 members). However, the percentage of households in the extreme family size ranges (11-15 and 16-20) is relatively smaller compared to the middle ranges (1-5 and 6-10). The distribution of family sizes can have implications for various aspects of society, such as housing needs, educational resources, healthcare services, and social support systems. Larger families may require more spacious homes, while smaller families might have different housing requirements.

Volume of Postharvest Losses

The result as presented in Table 1 shows the most frequent percentage loss range is 15-19.9%, accounting for 28% of the total occurrences. This suggests that a significant number of yam farmers in Nigeria experience losses within this range. The

Table 1. Percentage distribution of postharvest losses of yam.

Percentage Loss	Frequency	Percentage
0.1-4.9	32	20
5.0-9.9	11	7
10-14.9	39	24
15-19.9	44	28
20-24.9	21	13
25 and above	13	8
Total	**160**	**100**

second most frequent range is 10-14.9%, accounting for 24% of the total occurrences. This indicates that a considerable portion of yam farmers face losses within this range as well. The least frequent range is 25 and above, with 8% of the total occurrences. Although this range has the lowest frequency, it still indicates that some yam farmers in Nigeria suffer substantial losses of 25% or more.

Based on this result, it can be inferred that yam farmers in Nigeria face significant losses. Yam is a staple crop in Nigeria, and the losses can have serious implications for both the farmers and the country's food security.

Factors contributing to these losses could include various challenges such as pests, diseases, inadequate storage facilities, post-harvest losses, lack of access to proper agricultural practices and technologies, and adverse weather conditions like drought or excessive rainfall.

Addressing these challenges is crucial for improving the overall productivity and profitability of yam farming in Nigeria. This can be achieved through measures such as improved farming techniques, better pest and disease management, investment in storage and processing infrastructure, access to credit and insurance, and the promotion of climate-smart agriculture practices. Government policies, research and extension services, and collaborations between relevant stakeholders can play a vital role in supporting yam farmers and minimizing their losses. Additionally, raising awareness among farmers about good agricultural practices and providing training programs can contribute to reducing yam losses in Nigeria. It's important to note that the given result provides a general overview of the losses faced by yam farmers in Nigeria. The specific reasons and extent of losses may vary depending on various factors such as geographical location, farming practices, and individual circumstances.

Stages where losses occur most

Figure 6 indicates the stages in the Yam value chain where losses occur the most. The result revealed a 16% loss during harvesting. Postharvest losses can occur during the harvesting stage if improper techniques are employed. Damage to the yam tubers during harvesting, such as cuts, bruises, or improper handling, can lead to spoilage and decay during subsequent stages. The result revealed a 14% loss during transportation/Loading and offloading. During transportation, yam tubers are susceptible to physical damage, especially if not handled with care. Rough handling, poor packaging, and inadequate transportation facilities can result in bruising, breakage, and spoilage, leading to postharvest losses. The loss at Storage is shown to be 32%. It is a critical stage where losses can occur due to improper handling, storage conditions, and pest infestations. Factors such as high temperatures, humidity, and inadequate ventilation can accelerate yam deterioration. Additionally, inadequate pest control measures can result in insect damage and decay, leading to significant postharvest losses. At the Processing stage, losses were found to be at 22%. The processing stage involves activities like peeling, slicing, drying, and packaging of yam products. Inadequate processing techniques, lack of proper equipment, and insufficient quality control measures can contribute to postharvest losses. Improper drying, for example, can lead to mold growth and spoilage of processed yam products. At the Marketing stage, the losses were up to 11%. This could be due to poor infrastructure, inadequate market linkages, and improper handling. Delayed transportation, improper storage facilities at marketplaces, and lack of market information can result in product deterioration and losses and only 5% is lost during consumption 5%. Although the

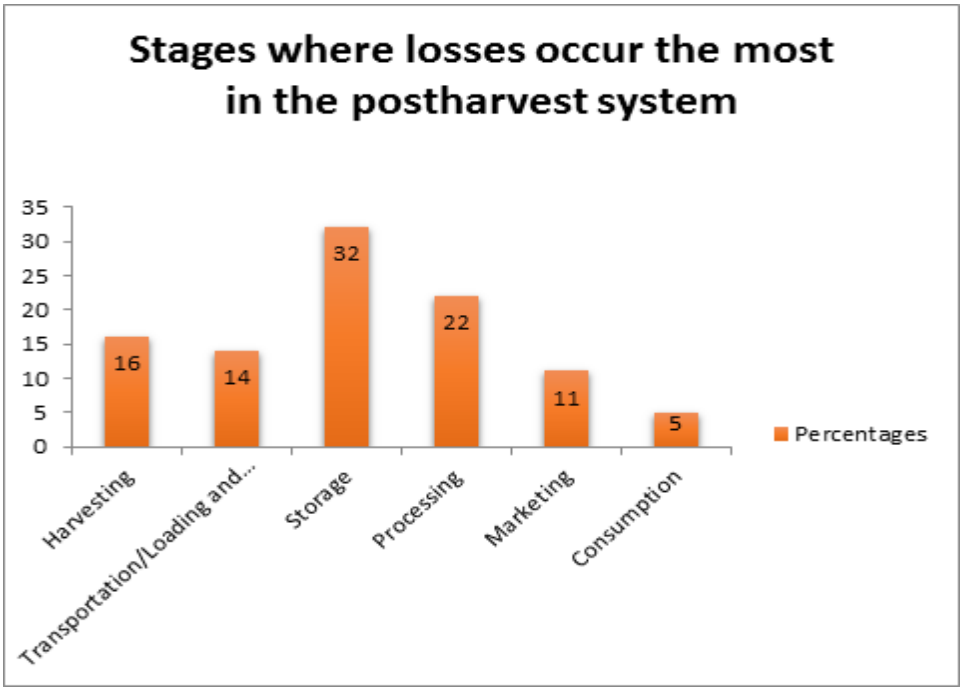

Figure 6. Stages where losses occur most in North-Central states of Nigeria

percentage of losses at the consumption stage is relatively low, it still exists. At the consumer level, losses can occur due to improper storage, mishandling, or inadequate utilization of yam products. Neglecting to consume yam within its shelf life or improper cooking methods can lead to waste and losses. Postharvest losses at each stage of the yam value chain have significant implications for overall food security, economic losses, and sustainability.

This finding is consistent with the assertions of Adamu et al., (2014) who opined that Among all the factors found to be responsible for losses of yams, poor storage methods seem to be the predominant reason for postharvest losses of yams in Nigeria. He further noted that postharvest losses of yam which result from poor storage constitute about 20-30%. Phillips et al., (2013) have confirmed that, on the whole, storage practices remain undeveloped and cause about 30% of both physical and economic losses in the yam value chain and it affects more of the farmers who engage in yam business as a primary source of income generation.

To mitigate these losses, several interventions can be implemented: Improved harvesting techniques and training for farmers to minimize damage during harvest. Investment in better transportation infrastructure and proper handling practices during loading and offloading. Adoption of appropriate storage technologies, such as improved packaging, controlled atmosphere storage, and pest management strategies. Promotion of good processing practices, including proper drying methods, quality control, and adherence to food safety standards. Strengthening market linkages, providing market information, and improving infrastructure at marketplaces to minimize losses during marketing. Promoting awareness and education among consumers regarding proper storage, handling, and utilization of yam products. By addressing postharvest losses at each stage of the yam value chain, stakeholders can reduce food waste, increase income for farmers, enhance food security, and improve the overall efficiency and sustainability of the yam sector.

Causes of Postharvest Looses of Yam Along the Value Chain (Multiple Response)

Figure 7 presents responses from farmers regarding the causes of postharvest losses of yam at the harvest stage. According to the data, the majority of farmers, 90%, identified bruises during harvesting in mature yam as the primary cause of losses. This was

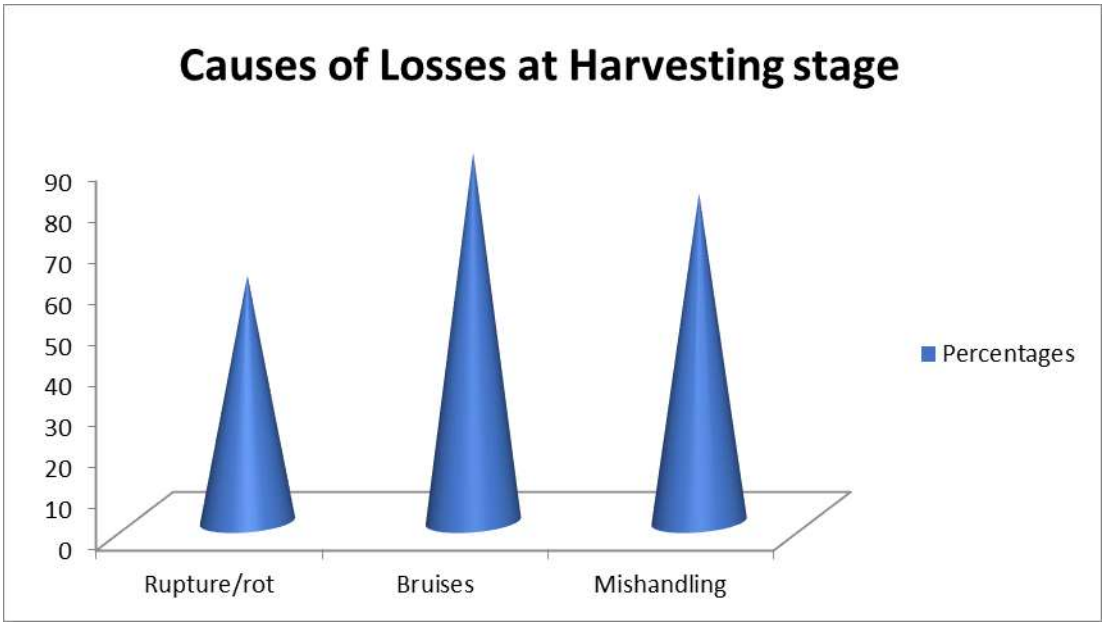

Figure 7. Causes of losses of yam at harvesting stage.

followed by mishandling, indicated by 80% of the farmers, and rot, mentioned by 60% of the farmers. This is because Yam tubers are susceptible to physical damage and bruising during the harvesting process, particularly when they have reached maturity. Improper techniques, such as using sharp tools or excessive force during harvesting, can lead to bruises, cuts, and damage to the tubers' outer skin. Bruised yam tubers are more prone to spoilage, rot, and other forms of deterioration during subsequent handling, storage, and transportation stages.

The data provided responses from farmers based on losses due to transportation in the yam postharvest system (Figure 8). According to the figures, 96% of the farmers identified high transportation costs as a cause of losses, 100% pointed out bad roads as a factor while 54% of the farmers mentioned long distances to the market as contributing to losses during transportation. These findings have significant implications for postharvest losses of yam and food security.

The high cost of transportation poses a considerable challenge for yam farmers. Transporting yams from the production areas to the markets or processing facilities can be costly, especially if the transportation infrastructure is inadequate or inefficient. High transportation costs can significantly reduce farmers' profits and make it economically unviable to transport their yam to the desired markets. As a result, yam may be left unsold or underutilized, leading to postharvest losses and reduced income for farmers. The findings also revealed that poor road conditions are a common issue in many agricultural regions, including those involved in yam production. Bad roads can lead to delays, increased transportation time, and higher chances of physical damage to the yam tubers during transit. Bumpy and uneven roads can cause bruising, cuts, and other forms of damage, making the yam more susceptible to decay and spoilage. Furthermore, the difficulties in navigating bad roads can also lead to higher transportation costs, exacerbating the financial burden on farmers. According to the result, long distances between the yam production areas and the marketplaces contribute to postharvest losses. Extended travel times increase the exposure of yam tubers to unfavorable conditions, such as temperature variations and humidity levels, which can accelerate spoilage. Additionally, the longer the distance, the higher the chances of mishandling, improper storage practices, and delays in reaching the market, further increasing the risk of postharvest losses.

The occurrence of postharvest losses in transportation has implications for food security. Yam is a staple food crop in many regions, and its availability and affordability are crucial for ensuring food security. When postharvest losses occur due to

Figure 8. Causes of losses at the transportation stage.

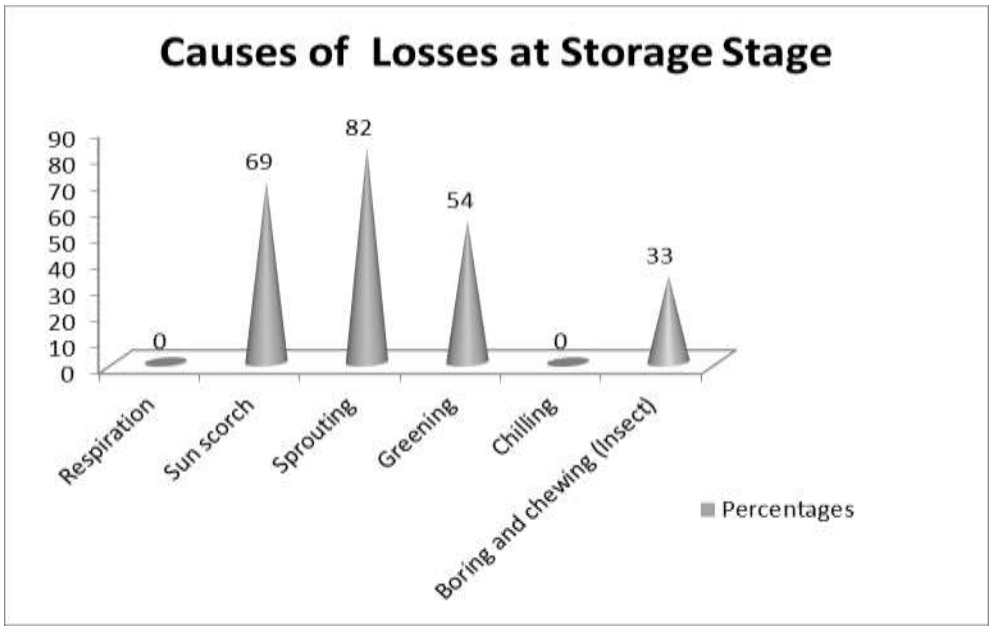

Figure 9. Causes of losses at the storage stage.

transportation challenges, the overall supply of yam in the market can be reduced. This can lead to increased prices, limited access to yam for consumers, and potential food shortages, particularly in areas heavily reliant on yam as a dietary staple. The result in Figure 9 showed that Sprouting (82%) is the most common cause of postharvest losses of yam during storage. It occurs when stored yam tubers start developing new shoots or sprouts. Sprouting is a natural response of yam tubers to changes in environmental conditions, and it indicates that the yam is still alive and attempting to grow. However, sprouting leads to weight loss, changes in taste and texture, and a decline in market value. It

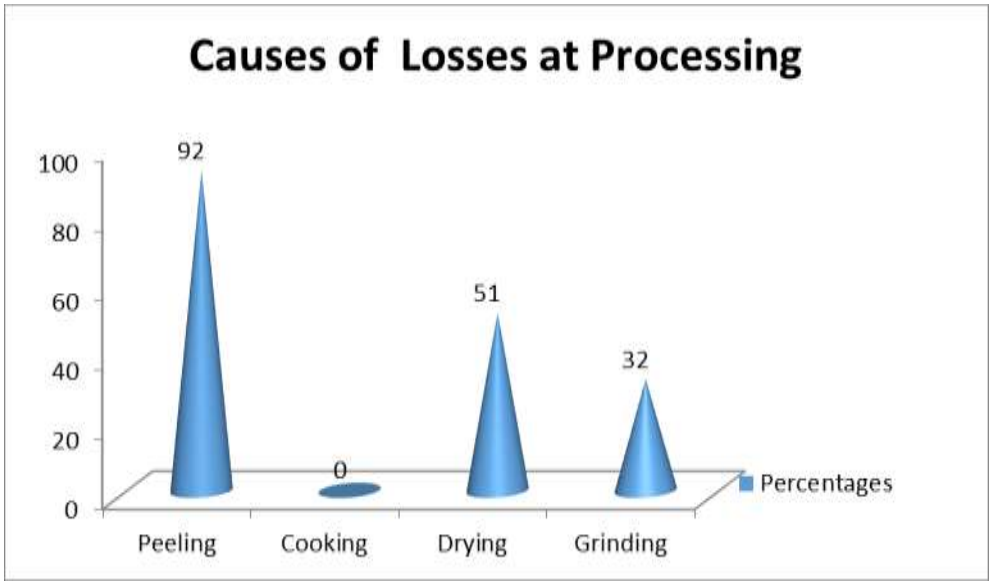

Figure 10. Causes of losses at processing stage.

can also render yam tubers more susceptible to rot and other forms of deterioration. Sun scorch (69%) refers to the damage caused to yam tubers when exposed to excessive heat and direct sunlight during storage. Sun scorch can lead to dehydration, discoloration, and overall deterioration of yam tubers. This can result in reduced quality, decreased market value, and increased postharvest losses.

The result also revealed that greening which is the development of a green color on the surface of yam tubers during storage is also a determinant of loss at the storage stage. It occurs when yam tubers are exposed to light. Greening is a result of the production of chlorophyll, and it indicates that yam tubers are undergoing photosynthesis. However, the green areas on the yam tubers can contain toxic compounds, making them unappealing and potentially harmful if consumed. Insects also cause significant damage to stored yam tubers by boring into them and feeding on the flesh. Insect infestations can lead to weight loss, physical damage, and increased susceptibility to decay. Infested yam tubers may also become unsuitable for consumption or processing, resulting in economic losses for farmers.

The identified causes of losses during storage have implications for postharvest losses and food security in Nigeria. If yam tubers suffer from sun scorch, sprouting, greening, or insect damage, their market value decreases. This can lead to financial losses for farmers and discourage them from storing yam for extended periods, limiting their ability to supply yam during lean seasons and impacting food security negatively. The identified causes of losses can result in a decline in the quality of stored yam tubers. Decreased quality affects consumer acceptance and demand, reducing market opportunities for farmers. It also limits the shelf life of yam and can contribute to increased postharvest losses. Postharvest losses during storage can lead to a reduced supply of yam in the market. Insufficient availability of yam affects its affordability and access for consumers, potentially leading to food shortages and compromised food security, particularly in regions where yam is a staple crop.

The identified cause of losses during peeling as shown in Figure 10 suggests that 92% of farmers out of the total surveyed experienced losses at this stage. Peeling is an essential step in yam processing, as it removes the outer skin or bark before further processing. Losses during peeling may occur due to various reasons, such as improper peeling techniques, mechanical damage to the yam tubers, or pest and disease infestation. These losses can lead to a decrease in the overall yield and quality of the processed yam, affecting the availability of food for consumers. The acknowledged cause of losses during drying indicates that 51% of farmers experienced losses during this stage. Drying is a crucial step in yam processing, as it helps reduce

Table 2. Probit Regression Analysis of the Effect of Postharvest losses of yam on Food Security North Central Zone of Nigeria.

Variables	Coefficient/ Estimate value	Standard Error	T-value	P-Prob (Z)
Yam lost during harvest	-0.0192	0.005	-2.281	0.001
Yam lost during storage	-0.0148	0.005	-3.452	0.002
Yam lost during transportation	-0.0276	0.004	-2.521	0.012
Yam lost during sorting, grading, and cleaning	-0.0293	0.004	-2.743	0.004
Chi-Square value = 514.845				

moisture content and extends the shelf life of the yam. Losses during drying can occur due to insufficient drying facilities or inappropriate drying methods. Factors such as high humidity, inadequate ventilation, or exposure to direct sunlight can contribute to mold growth, rotting, or insect infestation, leading to losses in quantity and quality. Grinding: The identified cause of losses during grinding suggests that 32% of farmers faced losses at this stage. Grinding is typically done to convert dried yam slices or chips into flour, which is used for various food preparations. Losses during grinding can arise from several factors, including inefficient grinding machines, contamination during the grinding process, or inadequate storage facilities for the resulting flour. These losses can lead to a decrease in the final yield of yam flour, affecting the availability of this important food product. The findings align with Costa's (2014) research, which emphasized that the primary concern regarding crop losses lies in the pre-farm gate stage of the supply chain. This stage encompasses inadequate harvesting, drying, processing, and storage practices, leading to significant percentages of crop losses. The inefficiencies in post-harvest management at this stage have a substantial impact on food loss and insecurity in Africa. The consequences directly affect the livelihoods of millions of smallholders farming households, severely affecting the availability of food for consumption and trade, particularly in low-income, food-deficient households and countries. Supporting this viewpoint, Idah et al., (2007) also highlighted the role of improper post-harvest sanitation, substandard storage, and packaging practices, and mechanical damage during harvest, handling, and transportation in exacerbating post-harvest losses of yam produce. Similarly, Gernah et al., (2013) emphasized these factors in their study on addressing food security challenges through agro-raw materials processing. They argued that inadequate road conditions, processing and storage equipment, and insufficient marketing information are primarily responsible for post-harvest losses in yam. They contended that these factors collectively contribute to inefficiencies in the human-managed food chain, particularly in the yam post-harvest system.

Effect of Postharvest Losses of Yam on Food Security

The Probit regression analysis (Table 2) examines the impact of postharvest losses of yam on food security in the North central zone of Nigeria. The coefficients/estimate values, standard errors, t-values, and p-values provide insights into the significance and direction of the relationship between the variables.

The coefficient values for each variable indicate their impact on food security. The coefficient value of -0.0192 suggests that an increase in yam losses during harvest is associated with a decrease in food security. This indicates that reducing losses during the harvest stage is crucial for improving food security. Enhancing harvesting practices, such as minimizing physical damage to yam tubers, using appropriate tools, and proper timing, can help mitigate losses and increase the availability of yam for consumption. The coefficient value of -0.0148 indicates that increased losses during storage are negatively related to food security. Proper storage facilities and practices, including adequate

ventilation, temperature control, and pest management, are essential for preserving the quality and quantity of yam. Minimizing losses during storage contributes to improving food security by ensuring a longer shelf life and availability of yam for consumption. The coefficient value of -0.0276 suggests that higher losses during transportation are associated with decreased food security. Efficient transportation systems, proper packaging, and handling methods are critical for minimizing losses during transit. By reducing losses during transportation, more yam can reach the market and consumers, enhancing food security. The coefficient value of -0.0293 indicates that increased losses during these stages negatively affect food security. Proper sorting, grading, and cleaning practices help eliminate damaged or defective yam tubers, ensuring higher quality and market value. Minimizing losses during these processes contributes to improved food security by maximizing the yield of usable yam. The finding is in consonant with Okoedo-Okojie and Onemolease (2009), Akangbe, et al., (2012) and Verter and Becvarova (2014) who opined that postharvest losses of yam reduce the profit margin of yam farming households, especially for those who engage in yam farming as a primary source of income and livelihood. Any loss thus, directly affects their income and invariably economic capacity which could have enabled them to improve their standard of living by attending to their domestic needs such as: access to health care services, access to good housing, access to education

The Chi-square value of 514.845 indicates the overall significance of the model in explaining the relationship between postharvest losses and food security. It suggests that the variables collectively have a substantial impact on food security in the study area. By addressing the factors contributing to losses during harvest, storage, transportation, sorting, grading, and cleaning, food security can be improved.

CONCLUSION

It is crucial to consider these demographic factors and provide appropriate training, support, and resources to farmers of all genders, ages, marital statuses, and educational backgrounds. By promoting inclusive and targeted interventions, the sustainable production of yam crops can be enhanced, leading to reduced postharvest losses and improved food security.

The survey results highlight the significant postharvest losses experienced by yam farmers in Nigeria. Factors contributing to these losses include bruises during harvesting, mishandling, rot, high transportation costs, bad roads, long distances to markets, sprouting, sun scorch, greening, and insect damage. The Probit regression analysis demonstrates that postharvest losses of yam significantly impact food security in the North Central zone of Nigeria. The coefficients/estimate values indicate that losses during harvest, storage, transportation, sorting, grading, and cleaning stages are negatively associated with food security. Reducing losses at each stage is crucial for improving food security in the region. The findings emphasize the importance of implementing measures to minimize postharvest losses and enhance the availability of yam for consumption. This includes adopting proper harvesting techniques, improving storage facilities, optimizing transportation systems, and implementing effective sorting, grading, and cleaning practices. By addressing these factors, farmers can increase their income, improve their standard of living, and have better access to essential services such as healthcare, education, and housing. Additionally, reducing postharvest losses contributes to the overall availability of yam in the market, ensuring food security for the population. The Chi-square value confirms the significance of the model, indicating that the combined effect of the variables studied has a substantial impact on food security in the North Central zone. Overall, the results underscore the need for interventions and policies that focus on reducing postharvest losses of yam to improve food security, enhance economic capacity, and promote sustainable agriculture in the region.

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